A Method of Interrogating Target Models in Pro/Engineer and an Associated Analysis

Sean Townsend
and
Kimberly Williams

February 23, 2000

OUTLINE

- Present Approach
- Pro/Engineer Based Approach
- Comparison

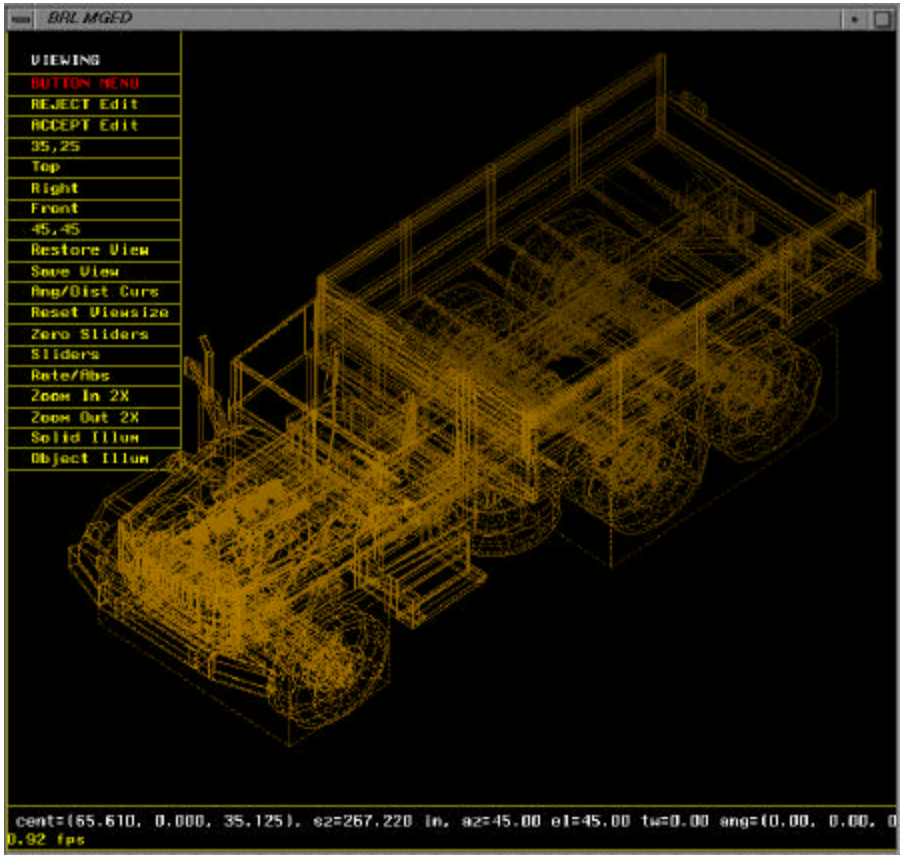
PRESENT APPROACH

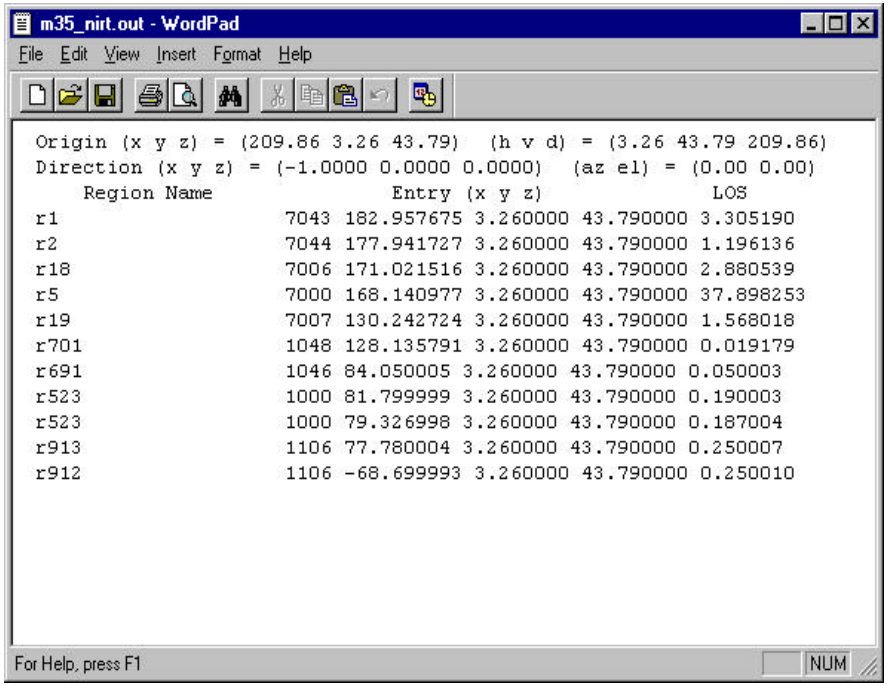
- **Present Approach**
- **Pro/Engineer Based Approach**
- **Comparison**

INTRODUCTION TO BRL-CAD

- BRL-CAD is the standard for lethality and survivability analyses in the Army
- BRL-CAD provides the tools needed by the lethality community
- Uses models created with the BRL-CAD mged function
- Interrogation accomplished using the ray-tracing library of functions
- Interrogation is the building block of lethality/survivability analyses

BRL-CAD SAMPLE





BRL-CAD DISADVANTAGES

- Commercial packages are easier to use
- Commercial packages continue to be developed quicker
- BRL-CAD is not the modeling choice outside of the lethality community
- Translation between BRL-CAD and other CAD packages can be resource intensive

PRO/ENGINEER BASED APPROACH

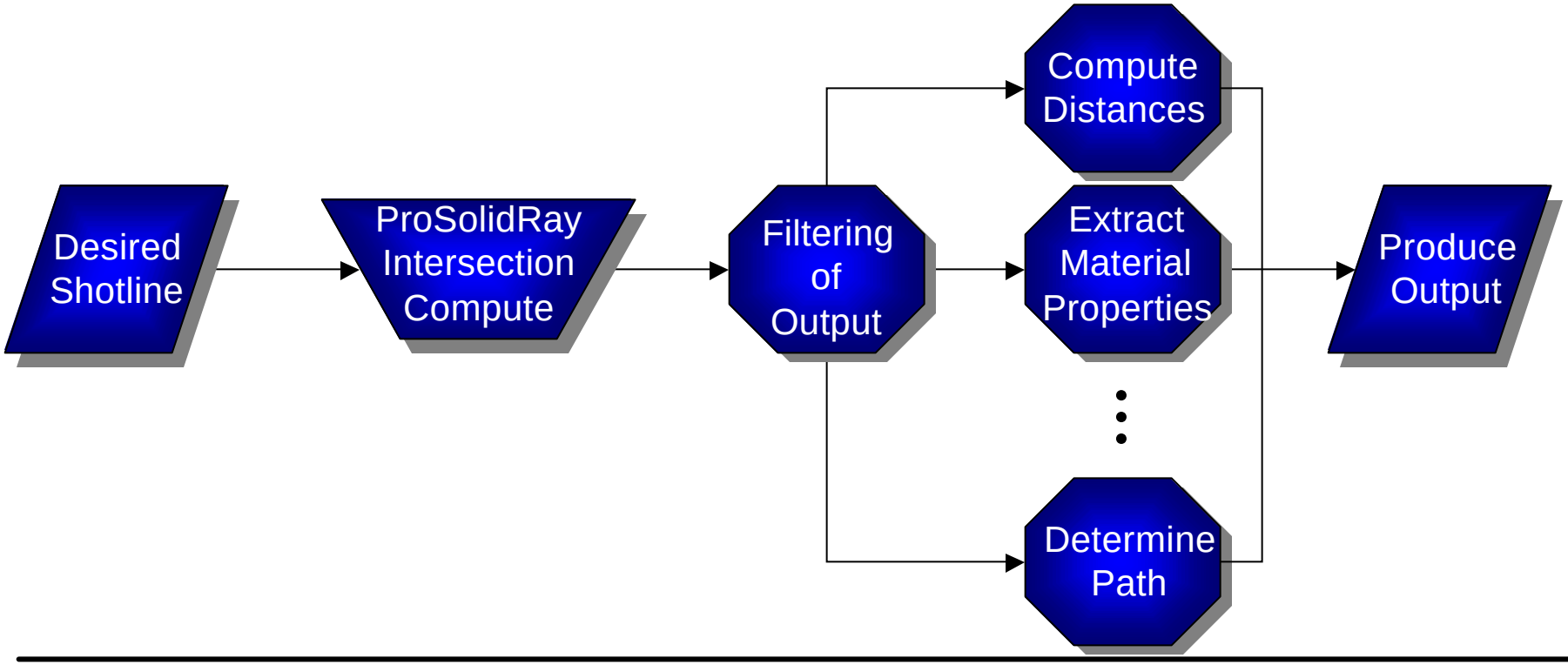
- Present Approach
- Pro/Engineer Based Approach
- Comparison

SLICE PURPOSE

- Allow for interrogation of Pro/E models in order to accomplish survivability / lethality analyses
- Leverage the modeling, simulation, and display advantages of commercial CAD packages
- Provide flexibility to the lethality/survivability community to allow resources to be used effectively
- Provide additional capabilities beyond those available within the BRL-CAD environment
- SLICE is meant to be a tool that compliments BRL-CAD, NOT a replacement for BRL-CAD

SLICE IMPLEMENTATION

- Implemented using ProToolkit
- Based upon **ProSolidRayIntersectionCompute**



SLICE OUTPUT

check.txt - WordPad

File Edit View Insert Format Help

```
region_info
IGNBOOSTER 5.000000 -3814.165697 5.401229 -1.501215 102.565697
IGNSUS 5.000000 -2670.066851 5.401229 -1.501215 105.766851
FUSE 5.000000 -2130.300000 5.401229 -1.501215 214.900000
EXPLOSIVE 1.650000 -1915.300000 5.401229 -1.501215 502.646963
WARHEAD 7.830000 -1411.869988 5.401229 -1.501215 61.185196
ALTIMETER 2.500000 -980.311289 5.401229 -1.501215 180.311289
GUIDENCECOMP 1.000000 -800.000000 5.401229 -1.501215 85.000000
SEEKERS 1.000000 -715.000000 5.401229 -1.501215 163.544508
SEEKERS 1.000000 -551.500000 5.401229 -1.501215 17.268474
SEEKERS 1.000000 -534.353166 5.401229 -1.501215 19.151465
NOSECONE 1.720000 -13.467063 5.401229 -1.501215 12.966831
```

For Help, press F1 NUM

LOS thickness

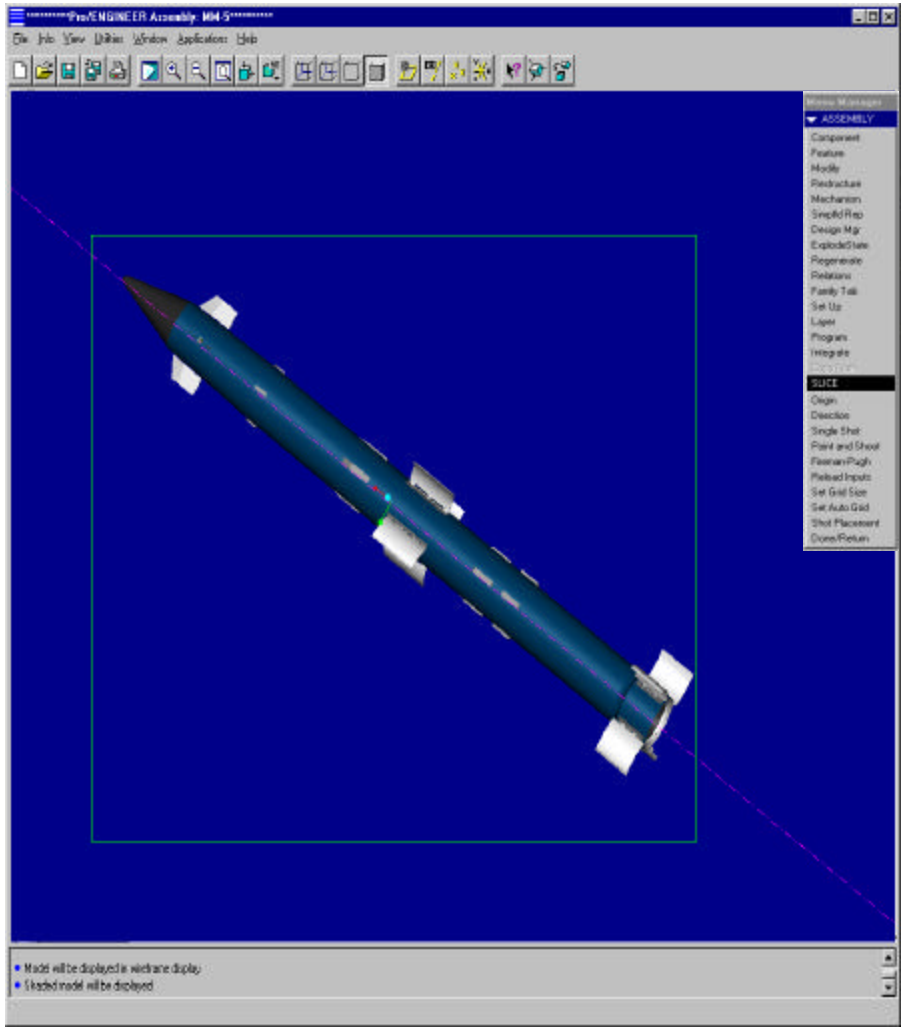
Entry point z coordinate

Entry point y coordinate

Entry point x coordinate

Material Density

Part name



COMPARISON

- Present Approach
- Pro/Engineer Based Approach
- Comparison

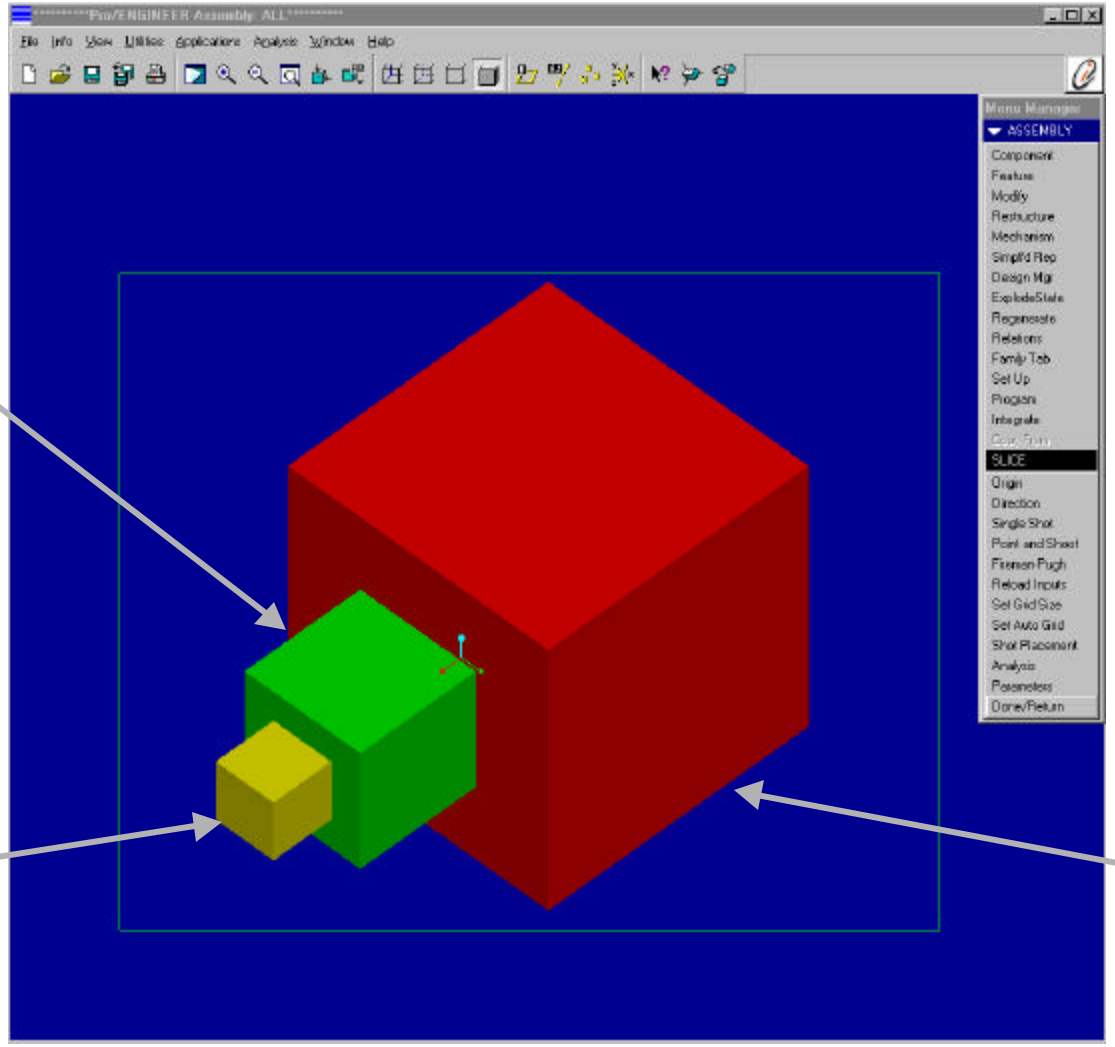
PRO/ENGINEER BOXES DEMO MODEL

BIG_BOX.PRT

4000 mm hollow cube with 100 mm walls

LITTLE_BOX.PRT

2000 mm hollow cube with 100 mm walls



SOLID_BOX.PRT

9000 mm solid cube

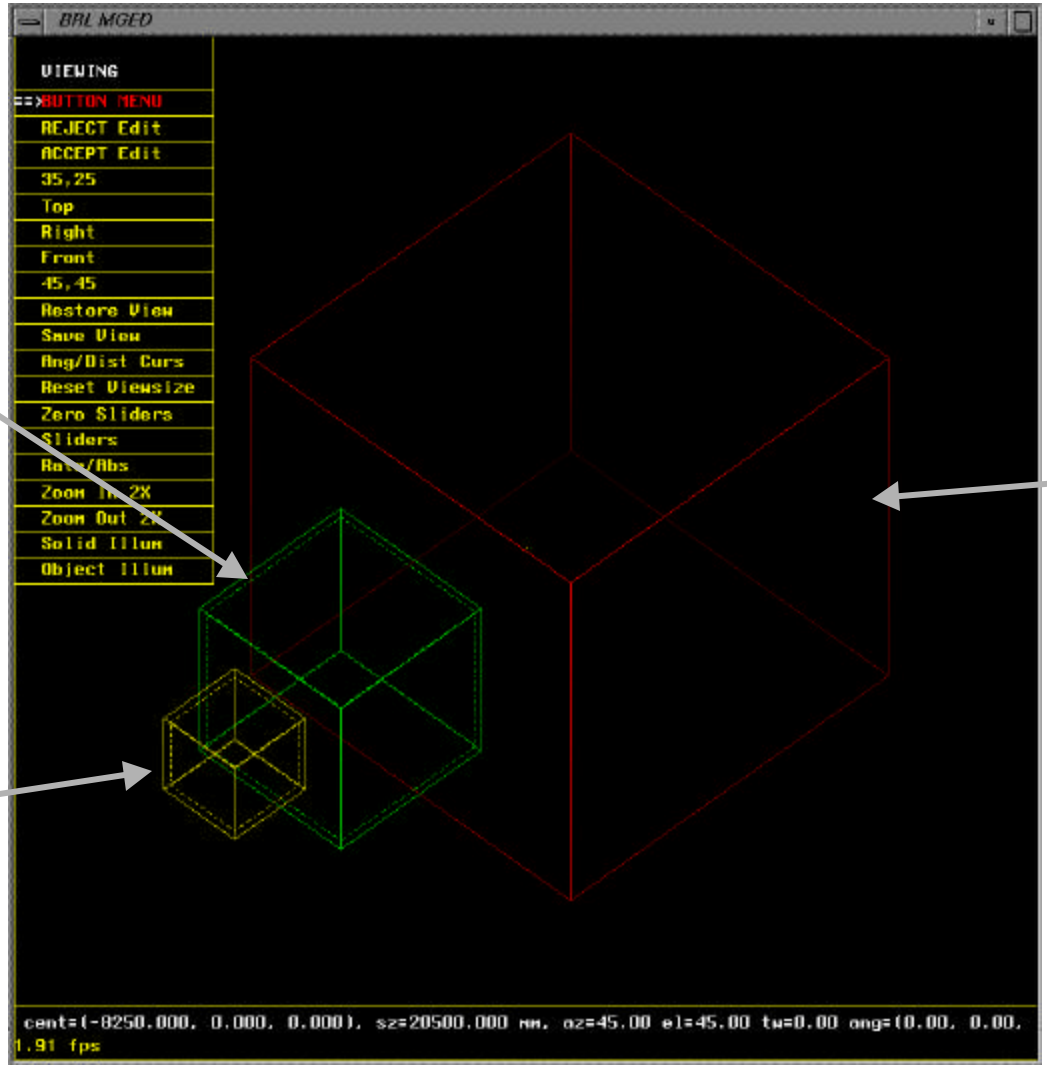
BRL-CAD BOXES DEMO MODEL

BIG_BOX.PRT

4000 mm hollow cube with 100 mm walls

LITTLE_BOX.PRT

2000 mm hollow cube with 100 mm walls



SOLID_BOX.PRT

9000 mm solid cube

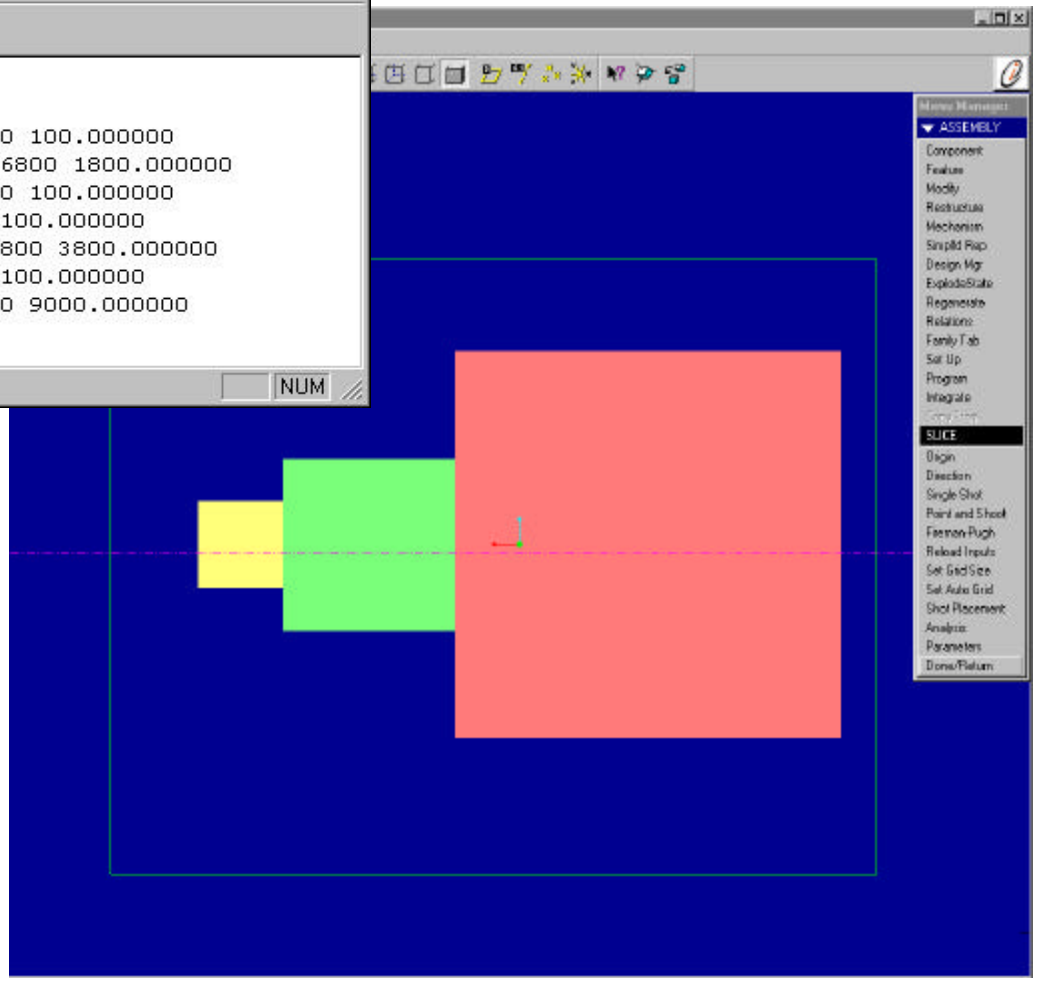
FRONT SHOT

check.txt - WordPad

File Edit View Insert Format Help

```
pk: 0.000000 0.000000 0.000000
region_info
LITTLE_BOX 7.764100 1000.000000 29.185800 -285.316800 100.000000
LITTLE_BOX_INT 0.001200 900.000000 29.185800 -285.316800 1800.000000
LITTLE_BOX 7.764100 -900.000000 29.185800 -285.316800 100.000000
BIG_BOX 7.764100 -1000.000000 29.185800 -285.316800 100.000000
BIG_BOX_INT 0.001200 -1100.000000 29.185800 -285.316800 3800.000000
BIG_BOX 7.764100 -4900.000000 29.185800 -285.316800 100.000000
SOLID_BOX 7.764100 -5000.000000 29.185800 -285.316800 9000.000000
```

For Help, press F1 NUM



FRONT SHOT COMPARISON

SLICE

check.txt - WordPad

File Edit View Insert Format Help

```
pk: 0.000000 0.000000 0.000000
region_info
LITTLE_BOX 7.764100 1000.000000 29.185800 -285.316800 100.000000
LITTLE_BOX_INT 0.001200 900.000000 29.185800 -285.316800 1800.000000
LITTLE_BOX 7.764100 -900.000000 29.185800 -285.316800 100.000000
BIG_BOX 7.764100 -1000.000000 29.185800 -285.316800 100.000000
BIG_BOX_INT 0.001200 -1100.000000 29.185800 -285.316800 3800.000000
BIG_BOX 7.764100 -4900.000000 29.185800 -285.316800 100.000000
SOLID_BOX 7.764100 -5000.000000 29.185800 -285.316800 9000.000000
```

For Help, press F1

NIRT

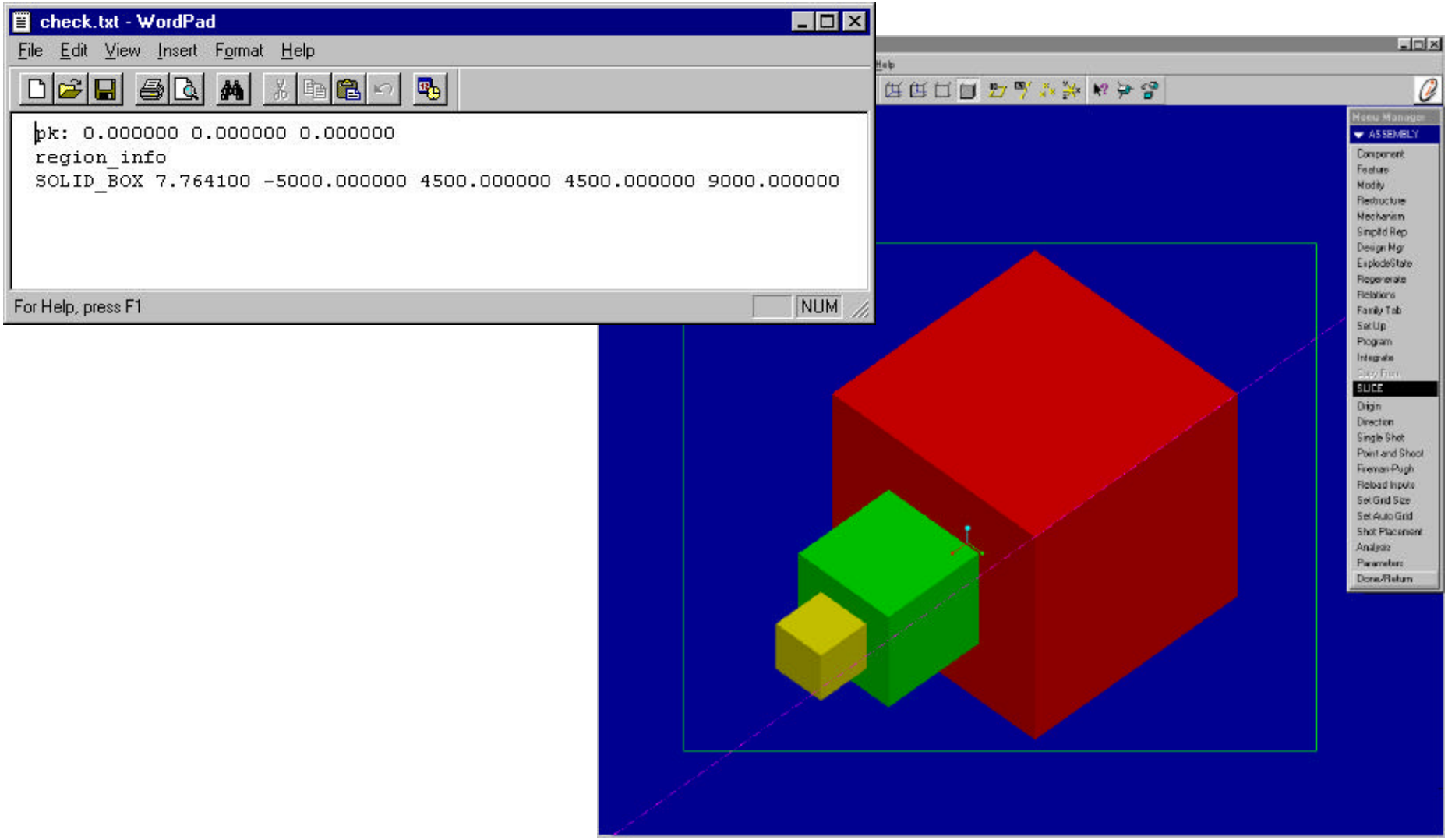
testbox_nirt.out - WordPad

File Edit View Insert Format Help

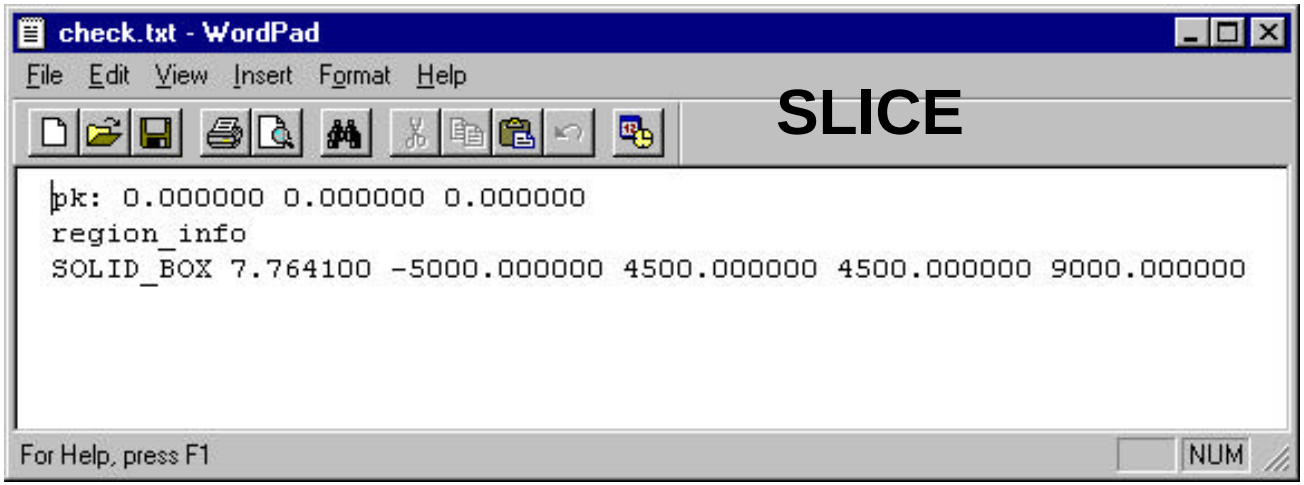
```
Origin (x y z) = (5000.00 29.19 -285.32)   (h v d) = (29.19 -285.32 5000.00)
Direction (x y z) = (-1.0000 0.0000 0.0000)   (az el) = (0.00 0.00)
    Region Name              Entry (x y z)              LOS
little_box          1000 1000.000000 29.185800 -285.316800 100.000000
little_box_int      101 900.000000 29.185800 -285.316800 1800.000000
little_box          1000 -900.000000 29.185800 -285.316800 100.000000
big_box             1001 -1000.000000 29.185800 -285.316800 100.000000
big_box_int         1010 -1100.000000 29.185800 -285.316800 3800.000000
big_box             1001 -4900.000000 29.185800 -285.316800 100.000000
solid_box           1002 -5000.000000 29.185800 -285.316800 9000.000000
```

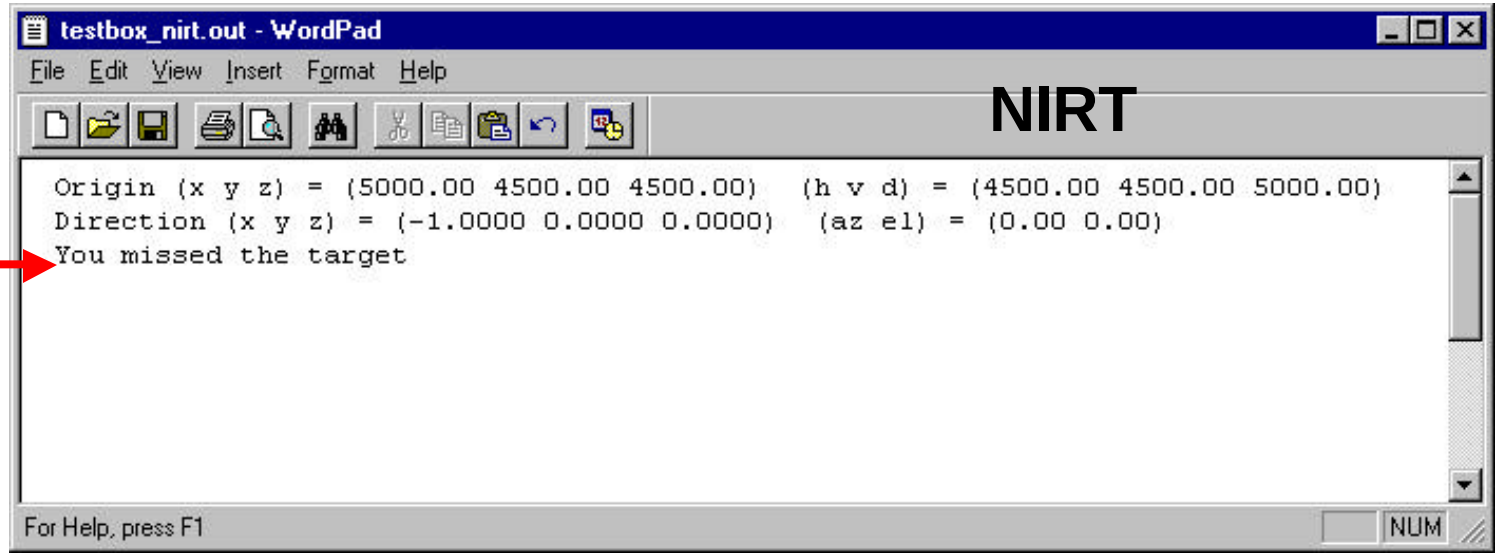
For Help, press F1 NUM

SLICE EDGE SHOT



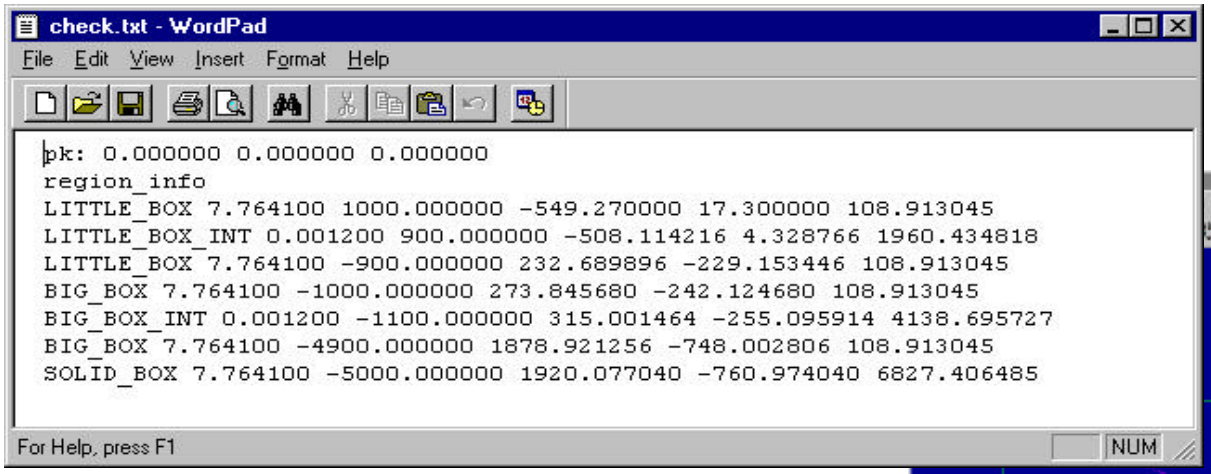
EDGE SHOT COMPARISON

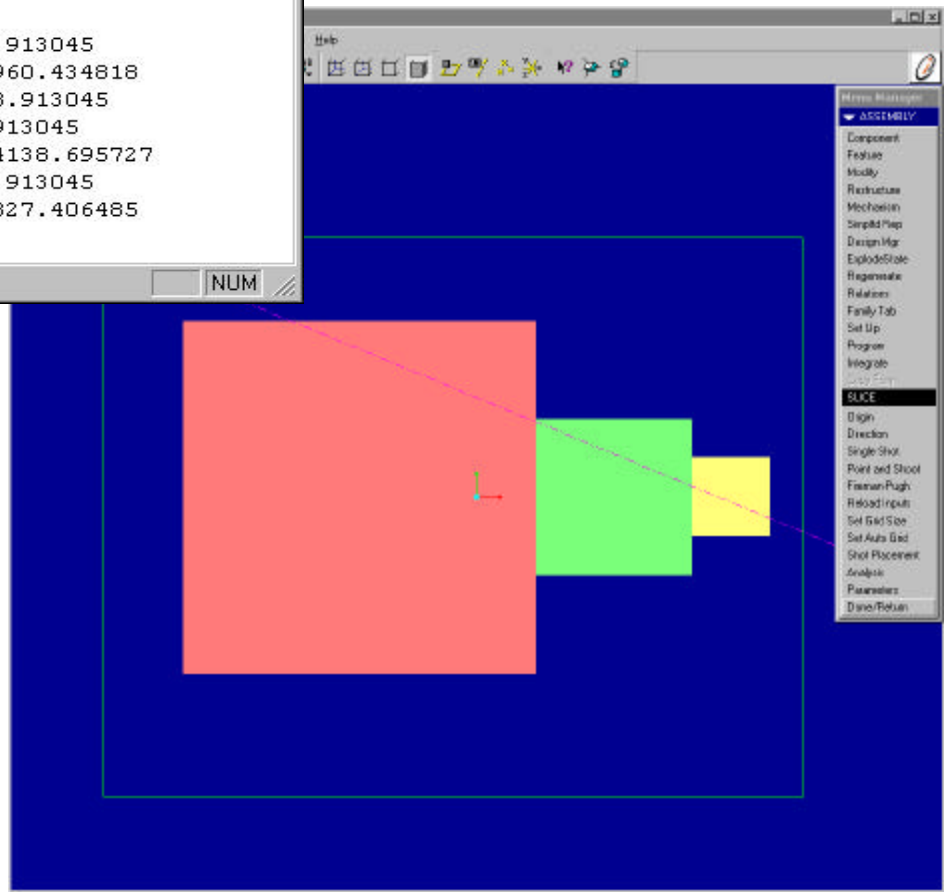




DIFFERENCE →

SLICE ANGLED FRONTAL SHOT





ANGLED FRONTAL SHOT COMPARISON

SLICE

check.txt - WordPad

File Edit View Insert Format Help

```
pk: 0.000000 0.000000 0.000000
region_info
LITTLE_BOX 7.764100 1000.000000 -549.270000 17.300000 108.913045
LITTLE_BOX_INT 0.001200 900.000000 -508.114216 4.328766 1960.434818
LITTLE_BOX 7.764100 -900.000000 232.689896 -229.153446 108.913045
BIG_BOX 7.764100 -1000.000000 273.845680 -242.124680 108.913045
BIG_BOX_INT 0.001200 -1100.000000 315.001464 -255.095914 4138.695727
BIG_BOX 7.764100 -4900.000000 1878.921256 -748.002806 108.913045
SOLID_BOX 7.764100 -5000.000000 1920.077040 -760.974040 6827.406485
```

For Help, press F1

NIRT

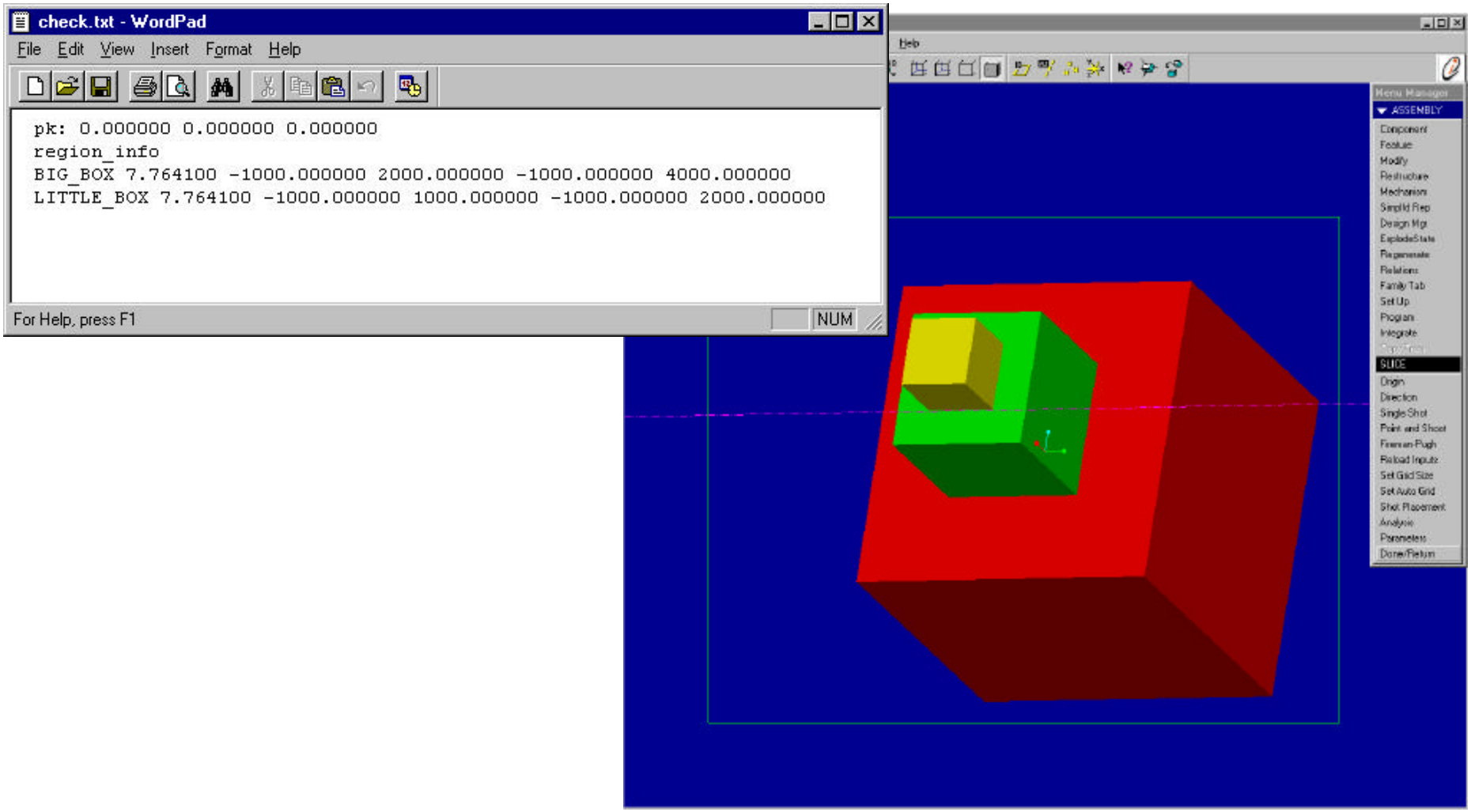
testbox_nirt.out - WordPad

File Edit View Insert Format Help

```
Origin (x y z) = (1000.00 -549.27 17.30)   (h v d) = (-127.35 -117.85 1127.78)
Direction (x y z) = (-0.9182 0.3779 -0.1191)   (az el) = (-22.37 6.84)
    Region Name                Entry (x y z)                LOS
little_box            1000 1000.000000 -549.270000 17.300000 108.913045
little_box_int        101 900.000000 -508.114216 4.328766 1960.434818
little_box            1000 -900.000000 232.689894 -229.153454 108.913045
big_box               1001 -1000.000000 273.845678 -242.124688 108.913045
big_box_int           1010 -1100.000000 315.001462 -255.095923 4138.695728
big_box               1001 -4900.000000 1878.921251 -748.002830 108.913045
solid_box             1002 -5000.000000 1920.077035 -760.974065 6827.406513
```

For Help, press F1 NUM

SLICE MATING FACES SHOT



MATING FACES SHOT COMPARISON

SLICE

check.txt - WordPad

File Edit View Insert Format Help

```
pk: 0.000000 0.000000 0.000000
region_info
BIG_BOX 7.764100 -1000.000000 2000.000000 -1000.000000 4000.000000
LITTLE_BOX 7.764100 -1000.000000 1000.000000 -1000.000000 2000.000000
```

For Help, press F1 NUM

NIRT

testbox_nirt.out - WordPad

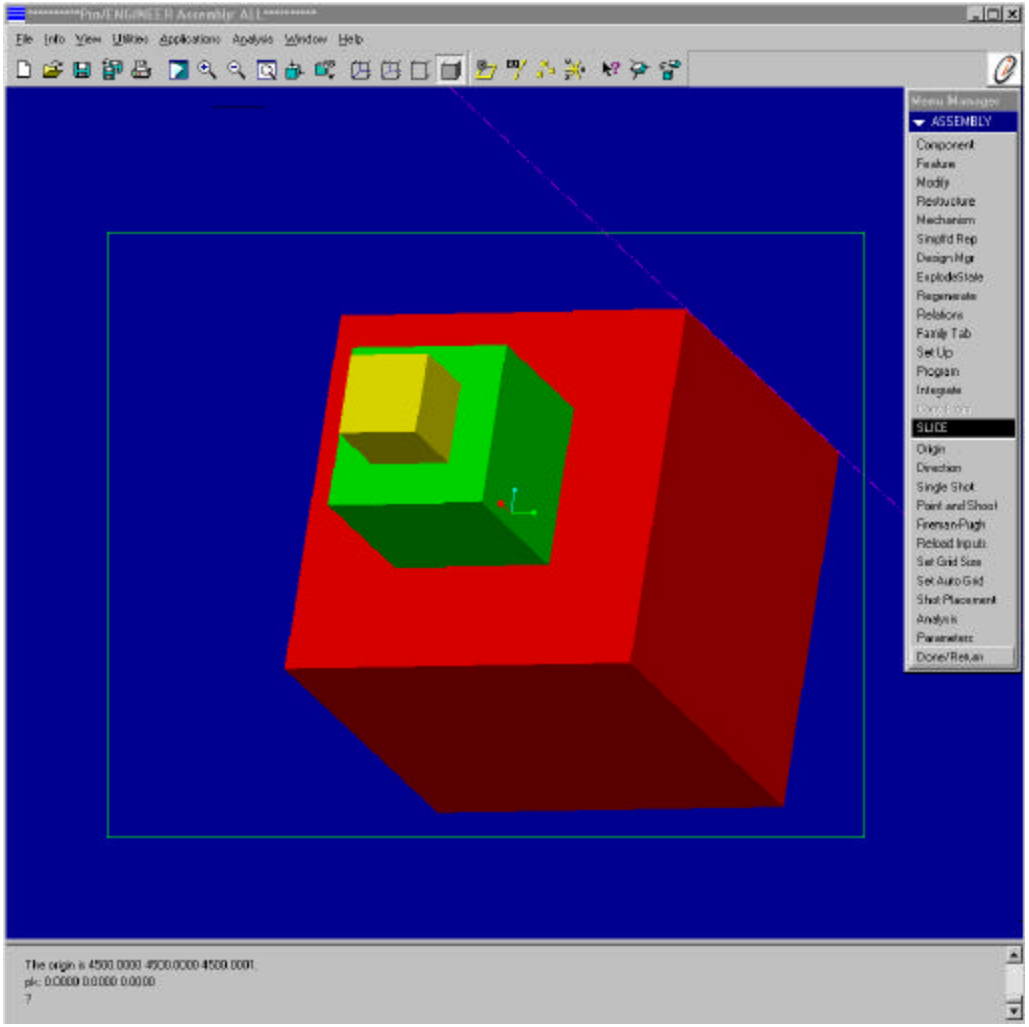
File Edit View Insert Format Help

```
Origin (x y z) = (-1000.00 5000.00 -1000.00)   (h v d) = (1000.00 -1000.00 5000.00)
Direction (x y z) = (0.0000 -1.0000 0.0000)   (az el) = (90.00 0.00)
    Region Name                Entry (x y z)                LOS
big_box                1001 -1000.000000 2000.000000 -1000.000000 1000.000000
OVERLAP: 'little_box' and 'big_box' xyz_in=(-1000 1000 -1000) los=2000
little_box             1000 -1000.000000 1000.000000 -1000.000000 2000.000000
big_box                1001 -1000.000000 -1000.000000 -1000.000000 1000.000000
```

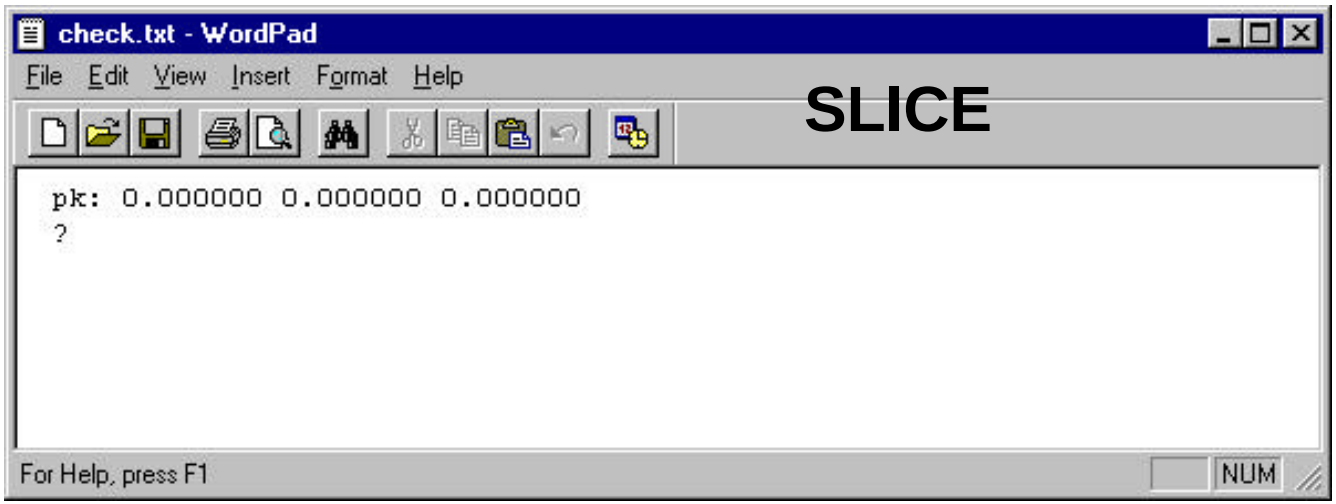
For Help, press F1 NUM

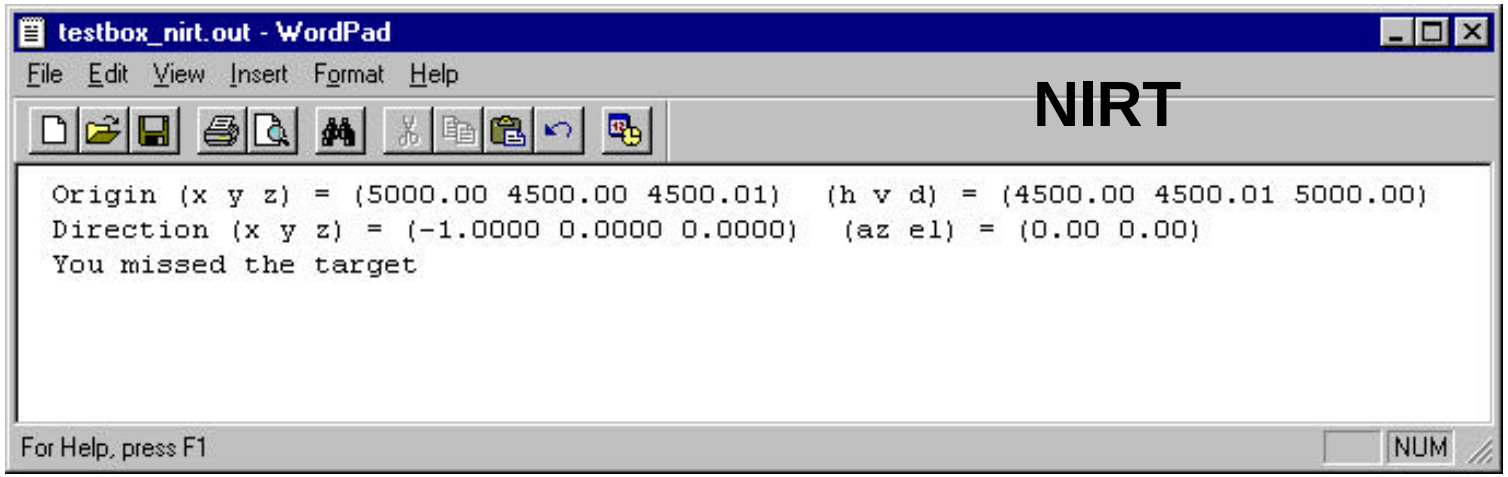
DIFFERENCE →

SLICE CLOSE SHOT

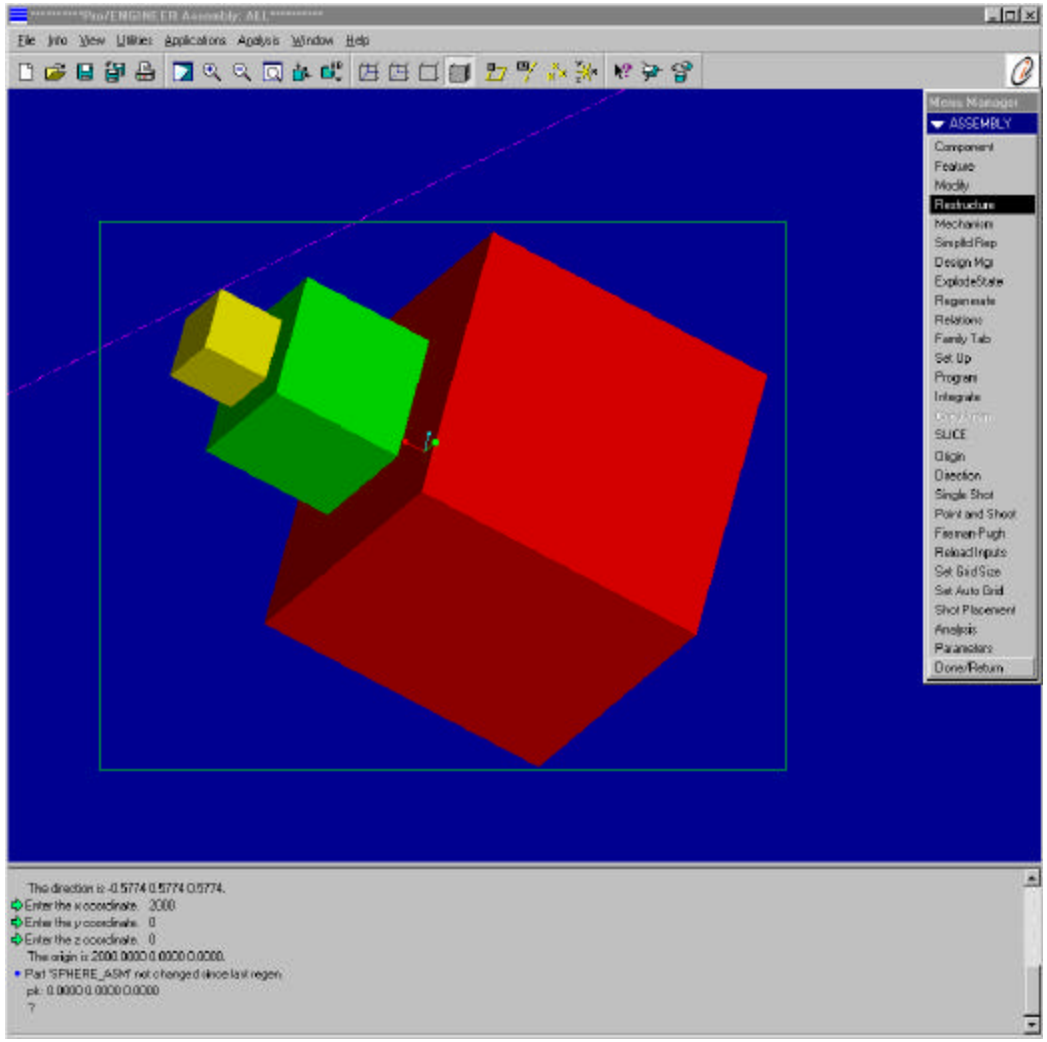


CLOSE SHOT COMPARISON

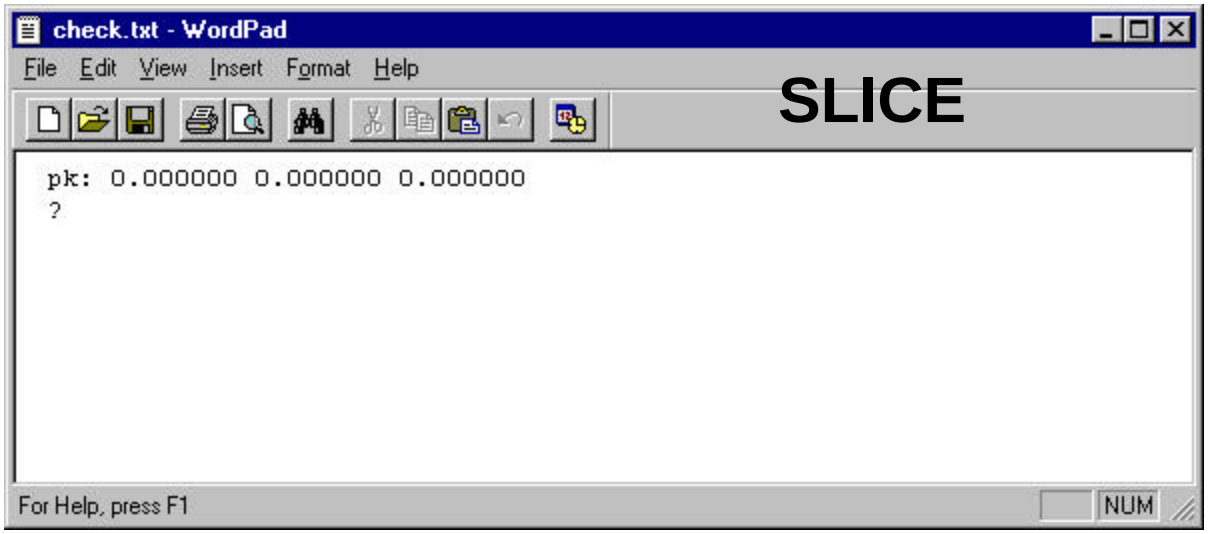




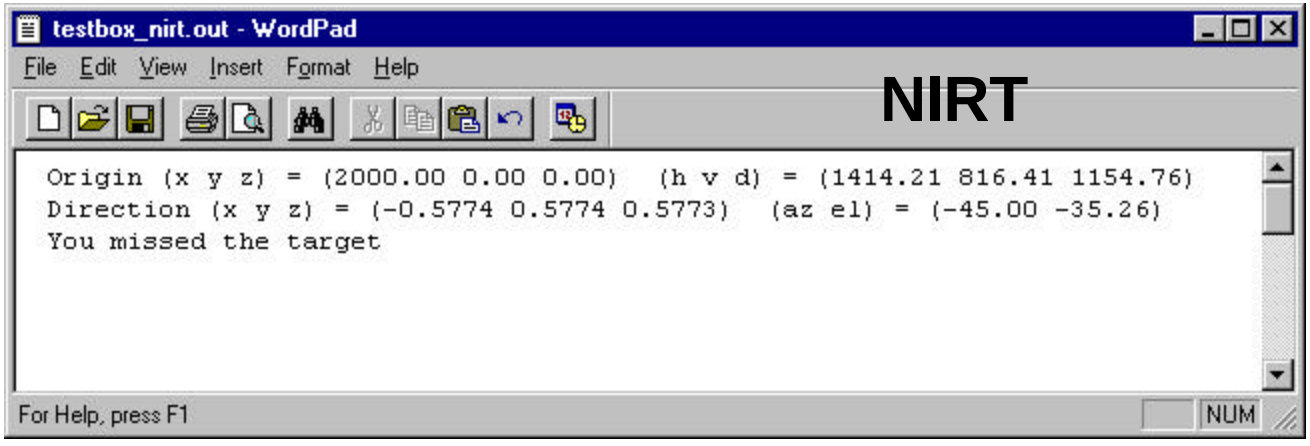
SLICE CORNER SHOT



CORNER SHOT COMPARISON

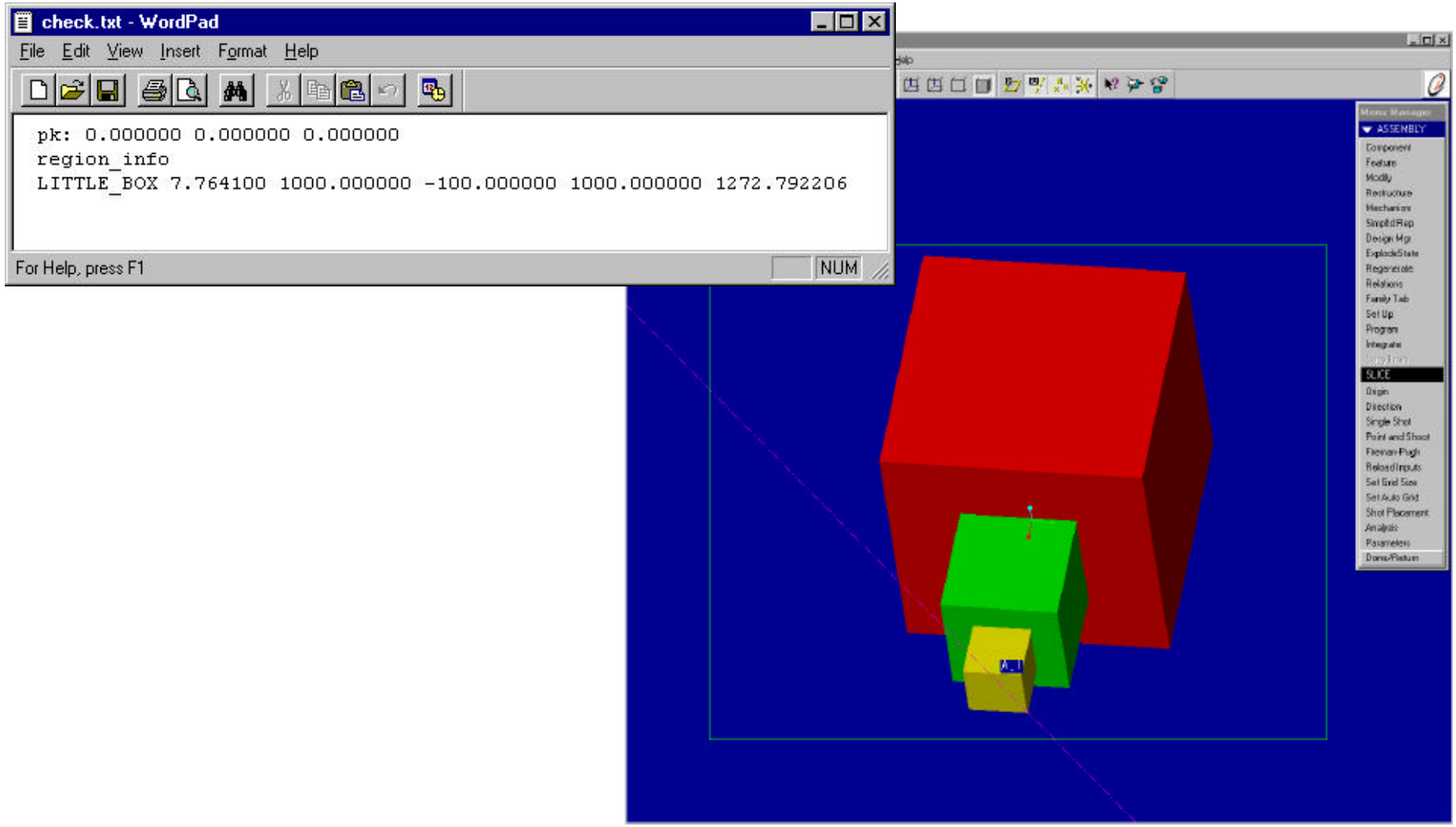


SLICE

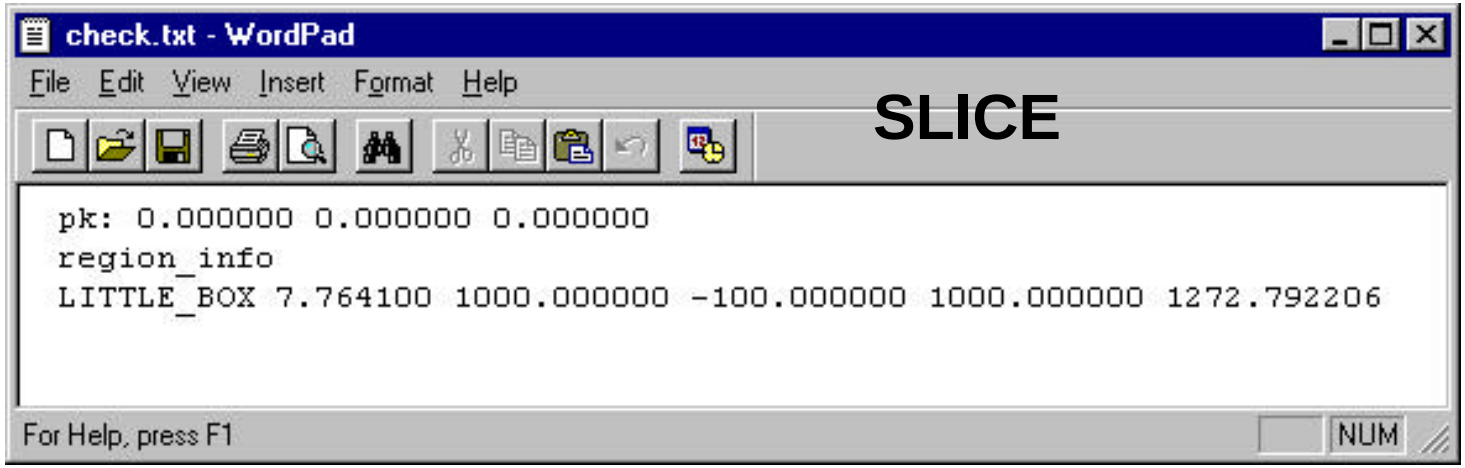


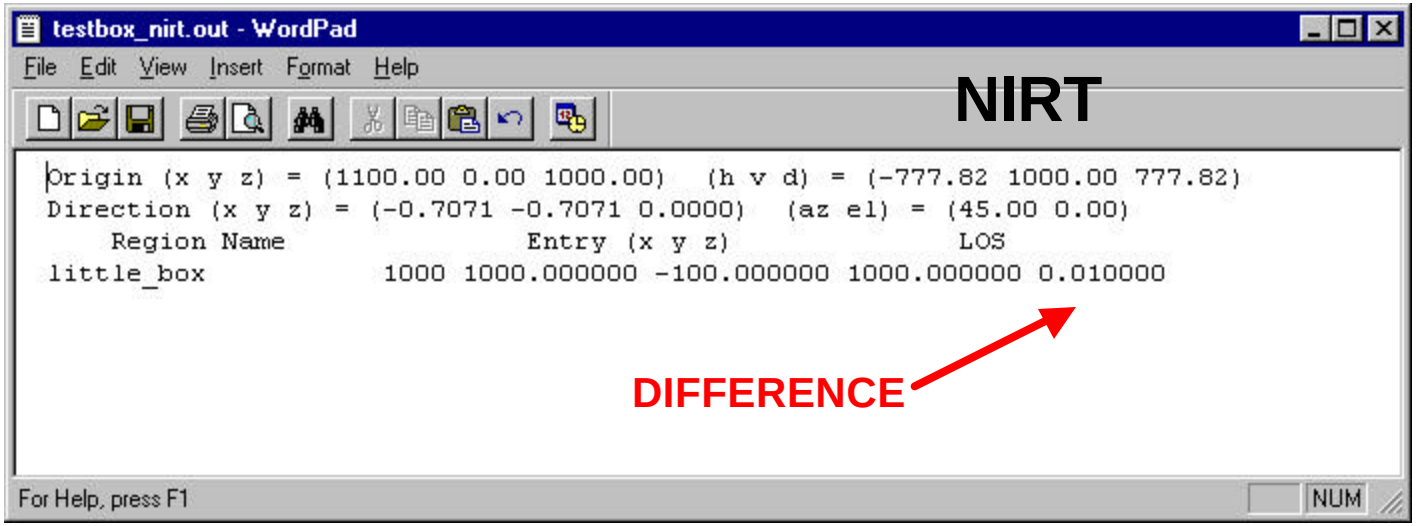
NIRT

SLICE FACE SHOT



FACE SHOT COMPARISON





CONCLUSION

- SLICE is a means of interrogating Pro/Engineer models
- SLICE provides equivalent results to BRL-CAD
- In some cases SLICE provides superior results to BRL-CAD
- SLICE provides additional capabilities not available within the BRL-CAD environment
- SLICE allows the survivability/lethality community to be more flexible and consequently shorten timelines and lower costs associated with model translations
- SLICE is meant to be a tool that compliments BRL-CAD, NOT a replacement for BRL-CAD